

Patent Application

of

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for

METHOD FOR FILTERING FLUIDS AND
DEVICE FOR IMPLEMENTING SAID METHOD

Background of the Invention

The present invention relates to a method and a device for filtering fluids. One input for the unfiltered material and one output for the filtrate as well as a plurality of stackable frame parts are provided, especially in the form of filtrate plates and filter frames. The respective filter frame borders the filtrate space for accommodating a forming filtrate cake, which on its side facing the next frame part in the stack is sealed by a laminar filter. The filtrate space with the filter cake which can be accommodated is bordered on its side opposite the laminar filter by another filter medium.

Background of the Invention

EP 1 140 317 B1 discloses a device used for continuous filtration of fluids by a pressure drop between an inlet and outlet of the device and for squeezing the remaining amounts of unfiltered material by a pneumatic pressurized medium before opening. The device has

- a plurality of filter plates in the form of a filter frame, which on both sides have a recess for holding a flat filter medium and are provided with drain channels for the filtrate,

- a plurality of membrane plates designed as a filter frame with ports, holes, and recesses for supply of the pressurized medium and covered on both sides with an elastic membrane, between the filter medium and the membrane a space for unfiltered material or filter cake being formed, the membranes which can be elastically stretched when exposed to pressure up to flat contact with the filter plates or the laminar filter material having a smooth surface on both sides, and in the relieved state adjoining the membrane plate over the entire surface,
- a frame which borders the unfiltered material space between the membrane plates and the filter plates,
- corresponding recesses in the filter plates and membrane plates which in the installed state form at least one respective feed channel for the unfiltered material and one respective drain channel for the filtrate, and
- end plates, holding, and fastening devices to detachably connect the filter plates and membrane plates to each other as a filter frame into a package.

This known filter device design is known as a filter press, but is used in the filtration process like a plate filter in which the filtrate is pressed through the filter medium by the fluid pressure drop between the inlet and outlet. As the filter medium, the known solution uses sections of a laminar filter material characterized by a labyrinth-like deep-bed filter structure which optionally permits both mechanically and adsorptively influenced separation of particles on the relatively long path through the filter medium in conjunction with different surface charges. Such laminar filter materials, which are also referred to as filter layers, are special cardboards for filtration of fluid media with the objective of separating coarse to extremely fine particles, colloids, microorganisms, and other undesirable components in order to obtain a filtrate of the desired high quality, and to obtain solid residues as filter cake.

Although very good separation results can be achieved with the known solution to devices and processes, it still leaves something to be desired, especially concerning the separation of extremely fine particles, such as albumin, globulin, protein substances, or the like from a blood plasma fluid or using the known solution for processes and devices for blood-plasma fractionation. In spite of squeezing by the membranes of the individual membrane plates within the filter device, active substances which are then lost for the further treatment processes can remain in the filter cake. This situation leads to losses on the cost side especially for very expensive products of active substances, such as albumin, globulin, and/or other special protein substances.

EP 0 759 318 A1 discloses a generic process and a device which serve the purpose of dehydration and drying of solid/fluid mixtures in which the slurry to be treated is dehydrated in a filter press and the filter cake is formed is dried by supplying heat. The filter cake formed in dehydration is pressed on each side against heating plates mounted between and parallel to two respective filter plates which are heated to a constant drying temperature. Pressing the filter cake against the surfaces of the heating plates is effected by a pressurized gas delivered by a collecting pipe and a drain. After heating the filter cake to a specified temperature, the supply of the pressurized gas is stopped, and a flushing gas under a low pressure is fed into the filter press and drawn off by the drain and collecting pipe. Switching from the pressurized gas (preheating phase) to flushing gas (vaporization phase) and vice versa is repeated until the desired degree of drying of the cake is achieved, whereupon the dried filter cake is removed conventionally by opening the filter press. In the known solution, two filter media always border one collecting space in which the heating rod is guided. With the known solution, it is possible on the one hand to jointly filter by the two filter media and to flush them jointly with a washing liquid (pressurized gas) supplied by a slurry feed. In this configuration, it cannot be precluded that active substances will remain in particular in the middle area of the filter cake, and will thus be lost for more extensive treatment processes.

Summary of the Invention

Objects of the present invention are to provide an improved method and apparatus for filtering such that as few active substances as possible remain in the filter cake to avoid loss for more extensive treatment processes, thereby to increase the cost efficiency of a filtration process, especially as regards extremely fine separation processes.

These objects are achieved by a process and a device where another fluid, especially in the form of a washing liquid, is fed through the other filter medium. The washing liquid, after flowing through the filter cake and the bordering laminar filter, leaves the device by its output. By a suitable washing liquid, which can vary in terms of its ingredients as a function of the filtration task, valuable substances and active substances remaining, for example, in the filter cake, can be washed out in this way and can be supplied to the filtrate side of the device to be available for further processing and treatment. Contrary to the most similar known solution, the washing liquid in the present invention is supplied by a filter medium, then flows completely through the filter cake located in the collecting space, and only then is discharged by the other filter medium which likewise borders the collecting space. Potentially expensive filtrate products, such as protein substances, albumin, globulin, etc., are then routed out of the device on the filtrate side on the outlet side so that the filtration performance with the process solution of the present invention is increased compared to the known solutions and the cost efficiency for the individual filtration processes is clearly increased by obtaining additional active substances.

By using a washing liquid routed in this way by a filter medium prior to its entry into the filter cake, an especially careful separation process of the active substances from the filtrate cake is also achieved. This separation is a factor especially when the active substances are sensitive to mechanical loads, for example, in the form of the pressure of the membrane of a membrane plate or the like. For processes of and devices for selective separation of active substances by the washing liquid, by using a laminar filter on one side of the filter cake and by using another filter medium on the opposing side of the filter cake with the corresponding flow through the filter layers and the

complete filter cake by the washing liquid, it is thus possible to completely omit mechanical processes of squeezing out the filter cake and to still achieve good separation rates for the active substance.

In one preferred embodiment of the device of the present invention, the laminar filter is formed from a deep-bed filter medium and the other filter medium is formed by a filter cloth or likewise from a deep-bed filter medium. Selectivity for the extremely fine substances to be separated can be defined by the suitable choice of filter cloths and/or deep-bed filter materials.

In another preferred embodiment of the process of the present invention, a compressive force is applied to the other filter medium such that the filter cake is pressed in the direction of the laminar filter. Preferably, to apply a compressive force to the other filter medium, a membrane is used which can be exposed to a pressurized medium, especially in the form of a gas, and which is a component of a membrane plate as another frame part of the device with which the process of the present invention can be implemented. Especially, for extremely fine substances which are less sensitive to mechanical compressive stress, the yield of separation products can then be increased in this way by the filtrate cake being not only washed, but compressed when provided with a compressive pressure. The yield of active substances on the filtrate side can be increased during the filtration process. Depending on the solution selected, it is possible to first compress the filter cake and then wash it. To implement these processes in a reversed sequence or at the same time to wash and to press the filter cake concomitantly, the washing liquid effects separation from one filter to the next adjacent one in a homogenous, uniform flow.

In another especially preferred embodiment of the process of the present invention, the laminar filter and the other filter medium are clamped between the plate-like frame parts, and cover the channels of the unfiltered material and filtrate which are connected to the input and output of the device. The respective filter layers and filter media can be tensioned between the frame parts and thus fixed within the device. Accordingly it is not necessary, as described in the

prior art (EP 1 140 317 B1) to insert the filter medium into recesses of the respective filter plate to then compress the sections of laminar filter material along the edge side between the filter plates and frame to form a seal. This insertion and compression result in frame parts with a complex structure, increasing production costs of the device.

The device as claimed in the present invention for implementing the described process is also part of the present invention.

Other objects, advantages and salient features of the present invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses preferred embodiments of the present invention.

Brief Description of the Drawings

Referring to the drawings which form a part of this disclosure:

FIG. 1 is a perspective view of one face of a device, according to a first embodiment of the present invention;

FIGS. 2 and 2b are side elevational views in cross section through one part of the stacked package of frame parts or the device of FIG. 1;

FIG. 2a is a front elevational view of one frame part of the device of FIG. 1;

FIGS. 3 and 3a are side elevational views in cross section through the stacked frame parts and a front elevational view of one frame part, respectively, of a device according to a second embodiment of the present invention; and

FIGS. 4 and 4a are side elevational views in cross section through the stacked frame parts and a front elevational view of one frame part, respectively, of a device according to a third embodiment of the present invention.

Detailed Description of the Invention

The filter device according to the present invention, shown in a perspective in FIG. 1, has front and rear mounting plates 10 and 12. The two mounting plates 10, 12 are held against each other in a horizontal plane by a beam-like support frame 14. Frame parts 16 with the support projections 18 molded onto them can be stacked from overhead on the support frame 14 and forced into compressive contact with each other. So that the individual frame parts 16 are held in their position on the support frame 14, on one end of the device, a pressing means 20 (not detailed) acts on the device and keeps the plate-like frame parts 16 against each other. On the front mounting plate 10, one input 22 in the form of a connection is provided for feed of the unfiltered material. Also, one output 24 is provided for the discharge of the filtrate. Such structure of this filter device is conventional and verifiable in a plurality of designs and embodiments in the prior art so that it will not be detailed here. Furthermore, the device shown in FIG. 1 can have ports (not detailed) which are not further specified for delivery of the pressurized medium, washing liquid and optionally additional channels and connecting points for the filtrate and unfiltered material.

In the first embodiment shown in FIGS. 2, 2a and 2b, the frame parts 16 in an alternating sequence form filtrate plates 26 and filter frames 28. The respective filter frame 28 borders a filtrate space 30 for holding a filter cake which is not detailed and which forms during filtration. This filtrate space 30 is sealed on its one side by a laminar filter 32 and on its side opposite the laminar filter 32. As a further boundary, filtrate space 30 has another filter medium 34 which is likewise a laminar filter in this embodiment. A deep-bed filter layer, as is specified by the prior art, is used as the filter medium of the respective laminar filter 32, 34.

This deep-bed filter layer is disclosed, for example, in DE 100 44 218 A1. This known solution is a filter which is equipped to be wet-proof, with a high swelling capacity in particular, which comprises a filter matrix containing cellulose fiber and which has open-pore cavities. The cellulose fibers on their surface have chemically bonded polyisocyanate. In one preferred embodiment, the known filter matrix has finely distributed microparticles in its cavities to facilitate extremely fine separation processes. As a result of the native fiber structure of the fiber matrix with cellulose fibers in this design, shrinkage processes can occur with subsequent drying or sintering of the matrix, with the result that in spite of intensified swelling behavior technically exact definition of the filtration properties is not possible.

Conversely, DE 102 29 291 proposes an improved filter material in the form of a deep-bed filter layer, comprising a support layer forming passages, with a first type of plastic fibers and with a definable proportion of native fibers. The first type of fibers are made as bicomponent fibers having a core with a high melting point, which core is surrounded by a jacket with a conversely lower melting point. In the filter material, a wet-proofing agent is provided and selected from the group of epichlorohydrin resins and/or melamine formaldehyde resins. This agent results in an essentially shrink-free, stable filter matrix structure with reliable connecting points with which constant filtration properties can be achieved, as well as extremely fine separation processes in order to be able to separate extremely small parts, such as microorganisms or proteins and protein substances, from fluid solutions. Such deep-bed filter layers are, therefore, especially suited for the filter device of the present invention. The solution of the present invention is furthermore characterized in that the filter media 32, 34 extend cloth-like with an essentially square cross section over the frame parts 16. In this way, they can be fixed by pressing between two frame parts 16.

In the embodiment shown in FIG. 2, the unfiltered material is supplied via input channels 36 to the individual frame parts 16 in the stack sequence (compare also FIG. 2a). The respective unfiltered material flows through the input channels 36 into the filtrate space 30, and there passes through the laminar filter 32 and the laminar filter 34 on both sides. The filtrate is then drained via

output channels 38, 40 which are mounted in succession in the horizontal plane. The other output channel 40 shown in FIG. 2b is in another section plane from output channel 38 in FIG. 2. As shown in FIG. 2a, the configuration of output channels 38, 40 is doubled, specifically extending at the top and bottom on the frame parts 16 and extending essentially in a horizontal plane to the input channels 36 for the unfiltered material. If at this point the filter cake has built up sufficiently in the respective filtrate space 30, it still has corresponding contents which have not been filtered out. In order to recover these substances, the filter cake in the filtrate space 30 is washed out. For this purpose, a washing liquid, which is not detailed, is supplied on the input side via the filter output channel 38. After passing through the filtrate plates 26, the filter medium 34, the filtrate cake in the filtrate space 30 and the laminar filter 32, the washing liquid with the active substances obtained by washing travels into the filtrate plate part 26, which is the middle one as viewed in FIG. 2, and from there drains via output channel 40. In this process, the specific configuration permits careful washing of the filter cake uniformly over the surface. Furthermore, with this configuration, the active substances can be obtained especially carefully without other pressurized media. For extremely fine substances which react sensitively to mechanical loading, the configuration of the filter package as shown in FIG. 2 is recommended.

The following embodiments shown in FIGS. 3 and 4 are described below only to the extent that they differ essentially from the preceding embodiments.

Furthermore, the same components are provided with the same reference numbers, and the above description in this respect also applies to the other embodiments.

In particular, the other two embodiments as shown in FIGS. 3 and 4 differ from the embodiment as shown in FIG. 2 in that for pressing of the filter cake, a pressurized medium, especially in the form of a pressurized gas, acts on a membrane 42 of a membrane plate 44. Membrane plate 44, as another frame part 16 in the stack, is added to the other frame parts in an alternating sequence of that embodiment shown in FIG. 2.

In the embodiment shown in FIG. 3, on the right one respective deep-bed filter medium as the respective laminar filter 32 is inserted toward the edge-right-side boundary of the filtrate space 30, as viewed in FIG. 3. On the opposite side, a filter cloth 46 of conventional structure as another filter medium borders the filtrate space 30. As FIG. 3 furthermore shows, along one middle plane, the respective membrane plate 44 has two membranes 42 which are separated by one chamber wall 48. Between the chamber wall 48 and the respective membrane adjacently opposite, a pressure space 50 is formed by delivering and draining a pressurized fluid via the pressure channels 52 (compare FIG. 3a). The respective membrane 42, for example, in the form of a rubber-elastic membrane, is pressed in the direction of the adjacently opposite filter cloth wall 46. The respective filter cloth 46 is provided with a definable fluid permeability. Furthermore, the respective membrane 42 with the filter cloth 46 assignable thereto borders a washing chamber 54 which can be supplied with a definable washing liquid by other channels 56 (compare FIG. 3a).

In this second embodiment, the unfiltered material (suspension) in turn is supplied to the device by the two channels 36 and is delivered to the filtrate space 30 and separated from the solid. The fluid coming from the filtrate space 30 then flows through the deep-bed filter layer 32, and is collected by the respective filtrate plate 26 and drained through the two filtrate channels 38. After filtration, the solid collected in the filtrate space 30 of the filter frame 28 can be squeezed using the membranes 42 if a pressurized medium is supplied to the device by the pressure channels 52. Next, the filter cake in the filtrate space 30 in the pressed state is washed. The washing liquid is supplied to the device by the other two channels 56 (compare FIG. 3a) for this purpose. This washing liquid is then distributed by the free space or the washing chamber 54 between the respective pressing membrane 42 and the filter cloth 46 as another filter medium, and is pressed in an equal area through the filter cake in the filtrate space 30. Then, the washing liquid passing through the deep-bed filter layer in the form of a laminar filter 32, is collected in the filtrate plate 26 and then drained by the filtrate channels 38. Since in all these sequences it is not necessary to deform the deep-bed filter layer 32, reliable and optimum filtration and washing of the cake with the device of the present invention are ensured.

In the third embodiment as shown in FIGS. 4, 4a, the filtrate plates 26 basically are designed as membrane plates 44. Furthermore, the filter medium is preferably an elastically structured laminar filter 32 or a filter cloth 34 as another filter medium. The unfiltered material is in turn supplied from the top and bottom to the respective frame part 16 by the input channels 36. The filtrate is drained by the output channels 38, 40 likewise at the top and bottom on the respective frame part 16. The pressurized fluid is delivered and drained by the pressure channels 52 (compare FIG. 4a). The pressurized fluid or gaseous medium travels in this way into the pressure space 50 between the chamber wall 48 and the membrane 42. This time, the output 40 of the filtrate is available as the input for the washing liquid, and output of the washing liquid takes place by the output channels 38 of the other filtrate. In this way, there is the possibility, on the basis of alternation, of specifically squeezing the respective solid cake in the filtrate space 30 from one side or the other by the respective membrane 42, and in doing so washing the cake at the same time.

Optimized washing of the cake for the respective solid cake within the device is achieved with these solutions, on the one hand with mechanical pressure application by the pressure membrane and on the other hand without. With the solution of the present invention extremely fine substances, such as protein substances, albumin, and globulin can be carefully and economically filtered out of fluids within the scope of blood-plasma fractionation.

In order to ensure sealing of the filtration system to the outside, a circumferential closed seal (not shown) is present between the relevant frame parts in the respective clamping plane. Furthermore, this seal can be configured on the respective edge-side termination of the filter medium integrally thereon. To the extent filtrate spaces are discussed in the application, they are partially also designated as "unfiltered material space" in technical language so that the terms correspond to each other and can be equated to each other in this respect.

While various embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is: